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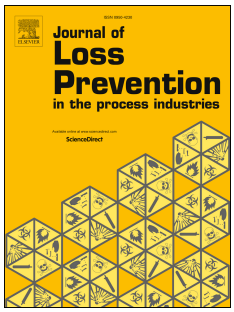

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Experimental study of leakage detection of natural gas pipeline using FBG based strain sensor and least square support vector machine

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Abstract

Leakage is the most common cause of natural gas pipeline accidents. This work was devoted to natural gas pipeline leakage detection, which is based on detecting negative pressure wave signals caused by leakage. The FBG strain sensor, which is based on monitoring the hoop strain of a pipeline to detect negative pressure wave signals, is fabricated and experimentally tested. Compared to conventional pressure sensors, FBG strain sensors were shown to be less influenced by noise, and they have the advantage of being a nondestructive sensing method. This makes them ideal for sensing pressure transients, which could be analyzed to detect natural gas pipeline leakage. Toward this objective, a least square support vector machine (LS-SVM) classifier was developed as an automatic leakage detection technique. This technique proved to be effective at detecting leakage.

1. Introduction

Natural gas pipelines account for almost half of the total length of pipelines in the world, which are prime candidates for natural gas transportation. Natural gas is poisonous and explosive. Therefore, it is important that natural gas pipelines are maintained in a safe manner.

Leakages are the major causes of in-service natural gas pipeline accidents, and many factors can lead to leakages such as corrosion, earthquakes and third party intrusion. In recent years, a number of technologies have evolved with the potential for pipeline leakage detection [1]. The negative pressure wave detection technique, which employs pressure sensors, is widely used [2]. The simple principle is that when leaks develop in a natural gas pipeline, the gas density near the leak point will decrease rapidly. This phenomenon results in a negative pressure wave, which propagates through the gas from the leak point. Pressure sensors installed upstream and downstream can detect such negative pressure waves. Accordingly, the signal captured by these pressure sensors can be processed to determine whether there is a gas leak. However, since the installation of pressure sensors requires localized deconstruction of the pipeline, pressure sensors cannot be installed easily. In engineering practice, pressure sensors are usually installed in compressor stations which are far apart. This inevitably leads to large signal attenuation and interference. Therefore, the traditional pressure sensor based negative pressure wave detection technique is ineffective to small rate leakage detection, and a high rate of false positives is often observed, which comprise some of the major drawbacks associated with this technique.

Distributed fiber optical sensors have been used to detect leakages in natural gas pipelines [3-5], a distributed fiber optical sensor installed along the pipeline can detect the temperature variation or vibrations caused by leakage. On the other hand, many other events can also lead to temperature variation or vibrations, such as environment

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